

CLAIMS

1 1. A traffic shaper for use in determining transmission start times for network
2 messages, the traffic shaper comprising:
3 a plurality of queues for storing information relating to the network messages;
4 a queue controller operably coupled to the plurality of queues for storing the in-
5 formation in and retrieving the information from the plurality of queues;
6 a scheduler in communicating relationship with the queue controller, the sched-
7 uler configured to compute release times for the network messages;
8 a memory for storing the computed release times; and
9 a memory controller operably coupled to the memory, the memory controller con-
10 figured to search the memory for computed release times,
11 wherein release times are computed and stored in the memory as information re-
12 lating to the network messages is retrieved from the queues.

1 2. The traffic shaper of claim 1 wherein the information includes a network mes-
2 sage length and a network message pointer.

1 3. The traffic shaper of claim 1 wherein each network message is associated with
2 a shaper identification (SID) value, and the traffic shaper further comprises a queue con-
3 trol memory accessible by the queue controller, the queue control memory including a
4 mapping of SID values to queues such that the information for a given network message
5 is mapped by the SID value associated with the given message to a specific queue.

1 4. The traffic shaper of claim 3 wherein the queue control memory further in-
2 cludes data for each queue indicating whether the respective queue is empty.

1 5. The traffic shaper of claim 4 wherein the scheduler comprises a rate monitor
2 configured to determine a rate at which network messages can be released, and a release
3 timestamp generator for computing release times based on the determined rates.

1 6. The traffic shaper of claim 5 wherein the determined network message release
2 rates are one of Committed Information Rate (CIR) and Excess Information Rate (EIR)
3 values.

1 7. The traffic shaper of claim wherein the memory comprises at least one content
2 addressable memory structure for storing computed release times, and corresponding a
3 random access memory structure for storing the SID values associated with the respective
4 release times stored in the content addressable memory structure.

1 8. The traffic shaper of claim 7 wherein the memory controller comprises a re-
2 trieve time generator for producing retrieve times that are used to search the computed
3 release times stored in the content addressable memory structure.

1 9. The traffic shaper of claim 8 further comprising a current time generator for
2 producing a current time, wherein the retrieve time produced by the retrieve time gen-
3 erator can catch up to but not exceed the current time produced by the current time gen-
4 erator.

1 10. The traffic shaper of claim 9 wherein upon identifying a release time stored in
2 the content addressable memory that matches the release time produced by the release
3 time generator, the memory controller provides the SID value associated with the
4 matching release time and the current time to the queue controller.

1 11. The traffic shaper of claim 10 wherein the queue controller, upon receiving a
2 SID value from the memory controller, accesses the queue control memory to identify the
3 queue corresponding to the received SID value, and retrieves the information from the
4 head of identified queue, thereby releasing the corresponding network message from the
5 traffic shaper.

1 12. The traffic shaper of claim 1 configured to support multiple levels of shaping.

1 13. A method for shaping network traffic by selectively releasing network mes-
2 sages, the method comprising the steps of:
3 providing a plurality of queues for storing data;
4 associating each queue with a corresponding shaper identification (SID) value;
5 receiving information related to a network message to be shaped, including a SID
6 value;
7 storing at least some of the received information at the queue corresponding to the
8 received SID value;
9 computing a release time for each queue containing network message informa-
10 tion;
11 storing the computed release times in a time-searchable memory structure; and
12 upon expiration of a computed release time, dequeuing network message infor-
13 mation from the queue corresponding to the expired release time.

1 14. The method of claim 13 wherein a new release time is computed for a given
2 queue in response to the step of dequeuing network message information from the given
3 queue.

1 15. The method of claim 14 further comprising the step of searching the time
2 searchable memory structure for expired release times.

1 16. The method of claim 15 wherein the network message information stored at
2 the queues includes a message length and a message pointer.

1 17. The method of claim 14 further comprising the steps of:
2 associating each computed release time stored in the time-searchable memory
3 structure with a corresponding SID value; and
4 upon expiration of a computed release time stored in the time-searchable memory
5 structure, using the associated SID value to identify the queue from which network mes-
6 sage information is to be dequeued.

1 18. The method of claim 17 wherein the step of computing a release time com-
2 prises the steps of:
3 determining, based on a rate at which network messages are being drained,
4 whether an excess information rate (EIR) or a committed information rate (CIR) is to be
5 used in the calculation; and
6 computing the release time based on the EIR or CIR as determined.

1 19. The method of claim 18 wherein the step of determining comprises the steps
2 of:
3 computing a level at which network messages are draining from the respective
4 queue;
5 comparing the level to a threshold;
6 if the new last updated level exceeds the threshold, selecting the CIR; and
7 if the new last updated level does not exceed the threshold, selecting the EIR.

1 20. The method of claim 19 further comprising the step of, upon dequeuing net-
2 work message information from a first queue in response to an expired release time, en-
3 queuing the network message information at a second queue.

1 21. A traffic shaper for use in determining transmission start times for network
2 messages, the traffic shaper comprising:
3 a plurality of queues for storing information relating to the network messages;
4 means for storing the information in and retrieving the information from the plu-
5 rality of queues;
6 means for computing release times for the network messages;
7 a memory for storing the computed release times; and
8 means for searching the memory for computed release times,
9 wherein release times are computed and stored in the memory as information re-
10 lating to the network messages is retrieved from the queues.

1 22. The traffic shaper of claim 21 wherein the release time computing means
2 comprises means for determining a rate at which network messages can be released, and
3 the release time computing means computes release times based on the determined rates.

1 23. The traffic shaper of claim 22 wherein the searching means comprises means
2 for producing retrieve times that are used to search the computed release times stored in
3 the memory.

1 24. The traffic shaper of claim 23 further comprising means for generating a cur-
2 rent time, wherein the retrieve time from the retrieve time producing means can catch up
3 to but not exceed the current time produced by the current time generator.

1 25. A computer readable medium containing executable program instructions for
2 shaping network traffic by selectively releasing network messages, the executable pro-
3 gram instructions comprising program instructions for:
4 providing a plurality of queues for storing data;
5 associating each queue with a corresponding shaper identification (SID) value;
6 receiving information related to a network message to be shaped, including a SID
7 value;
8 storing at least some of the received information at the queue corresponding to the
9 received SID value;
10 computing a release time for each queue containing network message informa-
11 tion;
12 storing the computed release times in a time-searchable memory structure; and
13 upon expiration of a computed release time, dequeuing network message infor-
14 mation from the queue corresponding to the expired release time.

1 26. The computer readable medium of claim 13 wherein a new release time is
2 computed for a given queue in response to the step of dequeuing network message infor-
3 mation from the given queue.

1 27. The computer readable medium of claim 14 further comprising programming
2 instructions for searching the time searchable memory structure for expired release times.

1 28. The computer readable medium of claim 15 wherein the network message in-
2 formation stored at the queues includes a message length and a message pointer.

1 29. The computer readable medium of claim 14 further comprising programming
2 steps for:

3 associating each computed release time stored in the time-searchable memory
4 structure with a corresponding SID value; and

5 upon expiration of a computed release time stored in the time-searchable memory
6 structure, using the associated SID value to identify the queue from which network mes-
7 sage information is to be dequeued.

1 30. The computer readable medium of claim 29 wherein the programming in-
2 struction for computing a release time comprises programming instructions for:

3 determining, based on a rate at which network messages are being drained,
4 whether an excess information rate (EIR) or a committed information rate (CIR) is to be
5 used in the calculation; and

6 computing the release time based on the EIR or CIR as determined.

1 31. The computer readable medium of claim 30 wherein the programming in-
2 structions for determining comprises the programming instructions for:

3 computing a level at which network messages are draining from the respective
4 queue;

5 comparing the level to a threshold;

6 if the new last updated level exceeds the threshold, selecting the CIR; and

7 if the new last updated level does not exceed the threshold, selecting the EIR.

1 32. The computer readable medium of claim 31 further comprising programming
2 instructions for, upon dequeuing network message information from a first queue in re-

- 3 sponse to an expired release time, enqueueing the network message information at a sec-
4 ond queue.